

**TRANSMITTAL LETTER TO THE UNITED STATES  
DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A  
FILING UNDER 35 U.S.C. 371**

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)

09/889831

INTERNATIONAL APPLICATION NO.  
PCT/DE99/04064INTERNATIONAL FILING DATE  
22 December 1999 (22.12.99)PRIORITY DATE CLAIMED  
23 January 1999 (23.01.99)

TITLE OF INVENTION: METHOD AND SYSTEM FOR RELOCATING HIDDEN OBJECTS IN IMAGES

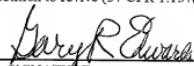
APPLICANT(S) FOR DO/EO/US: **Bernhard MOLOCHER and Karl NIEDERHOFF** **518 Rec'd PCT/PTO 23 JUL 2001**

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1.  This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2.  This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3.  This express request to begin national examination procedures (35 U.S.C. 371(f) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1)).
4.  A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5.  A copy of the International Application as filed (35 U.S.C. 371(c)(2)).
  - a.  is transmitted herewith (required only if not transmitted by the International Bureau).
  - b.  has been transmitted by the International Bureau. FORM PCT/IB/308 attached herewith.
  - c.  is not required, as the application was filed in the United States Receiving Office (RO/US)
6.  A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7.  Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
  - a.  are transmitted herewith (required only if not transmitted by the International Bureau).
  - b.  have been transmitted by the International Bureau.
  - c.  have not been made; however, the time limit for making such amendments has NOT expired.
  - d.  have not been made and will not be made.
8.  A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9.  An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)) **UNEXECUTED (2 pages)**
10.  A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

## Item 11. to 16. below concern other document(s) or information included:

11.  An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12.  An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13.  A **FIRST** preliminary amendment.
- A **SECOND** or **SUBSEQUENT** preliminary amendment.
14.  A substitute specification.
15.  A change of power of attorney and/or address letter.
16.  Other items or information: 1 sheet of drawings showing Figures 1 and 2; 1<sup>st</sup> page of published international application; Notification of the Recording of a Change.

U.S. APPLICATION NO. (Unknown) 1 <b>097889831</b>		INTERNATIONAL APPLICATION NO PCT/DE99/04064	ATTORNEY'S DOCKET NUMBER <b>420LFK/50041</b>																				
17. [X] The following fees are submitted:		CALCULATIONS PTO USE ONLY																					
Basic National Fee (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EPO or JPO ..... \$860.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) .. \$690.00 No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) ..... \$710.00 Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... \$ 1000.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) ..... \$100.00																							
<b>ENTER APPROPRIATE BASIC FEE AMOUNT = \$ 130.00</b>																							
Surcharge of \$130.00 for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)). <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Claims</th> <th>Number Filed</th> <th>Number Extra</th> <th>Rate</th> </tr> </thead> <tbody> <tr> <td>Total Claims</td> <td>6-20=</td> <td>0</td> <td>X \$18.00</td> </tr> <tr> <td>Independent Claims</td> <td>2-3=</td> <td>0</td> <td>X \$80.00</td> </tr> <tr> <td>Multiple dependent claims(s) (if applicable)</td> <td></td> <td></td> <td>+ \$270.00</td> </tr> <tr> <td colspan="3" style="text-align: right;"><b>TOTAL OF ABOVE CALCULATIONS = \$ 130.00</b></td> <td></td> </tr> </tbody> </table>				Claims	Number Filed	Number Extra	Rate	Total Claims	6-20=	0	X \$18.00	Independent Claims	2-3=	0	X \$80.00	Multiple dependent claims(s) (if applicable)			+ \$270.00	<b>TOTAL OF ABOVE CALCULATIONS = \$ 130.00</b>			
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<b>TOTAL OF ABOVE CALCULATIONS = \$ 130.00</b>																							
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).																							
<b>SUBTOTAL = \$ 990.00</b>																							
Processing fee of \$130.00 for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)). <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="3" style="text-align: right;"><b>TOTAL NATIONAL FEE = \$ 990.00</b></th> </tr> </thead> <tbody> <tr> <td colspan="3">           Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28,3.31). \$40.00 per property +  <b>TOTAL FEE ENCLOSED = \$ 990.00</b> </td> </tr> <tr> <td colspan="3" style="text-align: right;">           Amount to be:            refunded            charged         </td> </tr> </tbody> </table>				<b>TOTAL NATIONAL FEE = \$ 990.00</b>			Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28,3.31). \$40.00 per property + <b>TOTAL FEE ENCLOSED = \$ 990.00</b>			Amount to be: refunded charged													
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a. [X] A check in the amount of <b>\$ 990.00</b> to cover the above fees is enclosed. b. [ ] Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed. c. [ X ] The Commissioner is hereby authorized to charge any additional fees, which may be required, or credit any overpayment to Deposit Account No. <u>05-1323</u> . (Attorney Docket No. <b>420LFK/50041</b> ) A duplicate copy of this sheet is enclosed.																							
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.																							
SEND ALL CORRESPONDENCE TO: CROWELL & MORING LLP Intellectual Property Group P.O. Box 14300 Washington, DC 20044-4300 Tel. No. (202) 628-8800 Fax No. (202) 628-8844		 SIGNATURE <b>Gary R. Edwards</b> NAME <b>31,824</b> REGISTRATION NUMBER <b>23 July 2001</b> DATE																					

Attorney Docket: 420LFK/50041  
PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: BERNHARD MOLOCHER ET AL.

Serial No.: NOT YET ASSIGNED PCT No.: PCT/DE99/04064

Filed: JULY 23, 2001

Title: METHOD AND APPARATUS FOR LOCATING OR  
REDISCOVERING PARTIALLY OBSCURED OBJECTS IN  
IMAGES

PRELIMINARY AMENDMENT

Box PCT  
Commissioner for Patents  
Washington, D.C. 20231

July 23, 2001

Sir:

Please enter the following amendments to the specification,  
claims and abstract prior to the examination of the application.

IN THE SPECIFICATION:

A substitute specification is submitted herewith.

IN THE CLAIMS:

Please cancel all of the claims presently in the application  
and substitute new Claims 7-12 as follows:

7. (new) A process for determining location of an object  
in an image by correlation of an object reference with image  
values, wherein in case of a partial obstruction of an object

within the image, image values that lie within the coverage area are replaced by gray values of the object, before correlation is performed.

8. (new) The process according to Claim 7, wherein a reference image is subjected to interference windowing in order to replace the image values within an interference mask with gray values of the object.

9. (new) The process according to Claim 7, wherein the reference image is subjected to object windowing to obtain an object reference.

10. (new) The process according to Claim 7, wherein an image of the complete object is stored, and used to determine the position of object in case of a partial coverup.

11. (new) The process according to Claim 7, wherein parts of object that are obscured in the image, are replaced by parts of a stored reference.

12. (new) Apparatus for locating an object in an image, comprising:

a camera for taking a picture;

an image data memory to store an object reference;

an image data processor programmed to replace gray values that are within an obscured area in the image, with gray values of the object reference; and

a correlation unit that correlates the image, altered by the image data processor, with the object reference.

IN THE ABSTRACT:

Please substitute the new Abstract of the Disclosure submitted herewith on a separate page for the original Abstract presently in the application.

(Applicant's Remarks are set forth hereinbelow, starting on the following page.)

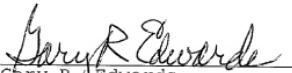
REMARKS

Entry of the amendments to the specification, claims and abstract before examination of the application is respectfully requested. These claims patentably define over the art of record.

If there are any questions regarding this Preliminary Amendment or this application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

It is respectfully requested that, if necessary to effect a timely response, this paper be considered as a Petition for an Extension of Time sufficient to effect a timely response and shortages in other fees, be charged, or any overpayment in fees be credited, to the Account of Crowell & Moring LLP, Deposit Account No. 05-1323 (Docket #420LFK/50041).

Respectfully submitted,

  
Gary R. Edwards  
Registration No. 31,824

CROWELL & MORING, LLP  
P.O. Box 14300  
Washington, DC 20044-4300  
Telephone No.: (202) 628-8800  
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GRE:kms

**ABSTRACT OF THE DISCLOSURE**

In a process for precisely locating partially obscured objects in images, an object reference is correlated with image values. When an object is partially obscured in the image, those image values that lie inside the coverage area in the image, are replaced by gray values of the object, before the correlation is performed. A camera takes a picture, and an image data memory stores an object reference. An image data processor replaces gray values that lie within the obscured area with gray values of the object reference; and a correlation unit correlates the image, altered by the image data processor, with the object reference.

Attorney Docket: 420LFK/50041  
PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: BERNHARD MOLOCHER ET AL.

Serial No.: NOT YET ASSIGNED PCT No.: PCT/DE99/04064

Filed: JULY 23, 2001

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REDISCOVERING PARTIALLY OBSCURED OBJECTS IN  
IMAGES

SUBMISSION OF SUBSTITUTE SPECIFICATION

Commissioner for Patents  
Washington, D.C. 20231

July 23, 2001

Sir:

Attached is a Substitute Specification and a marked-up copy of the original specification. I certify that said substitute specification contains no new matter and includes the changes indicated in the marked-up copy of the original specification.

Respectfully submitted,

  
Gary R. Edwards  
Registration No. 31,824

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GRE:kms

METHOD AND APPARATUS FOR LOCATING OR REDISCOVERING PARTIALLY  
OBSCURED OBJECTS IN IMAGES

BACKGROUND AND SUMMARY OF THE INVENTION

[0001] This application claims the priority of German patent document 199 02 681.5, filed 23 January 1999 (23.01.99) and PCT International Application No. 99/DE99/04064, filed 22 December 1999, the disclosure of which is expressly incorporated by reference herein.

[0002] This invention relates to a method and apparatus for locating or rediscovering partially obscured objects in images, by correlation of an object reference with image values.

[0003] Numerous practical uses require objects to be automatically rediscovered in images or digital image sequences. But it can happen that parts of the object are covered up or obscured by obstructions in the field of view.

[0004] In a known process for rediscovery of objects in images, the object image to be located stores a reference and that reference is subsequently correlated with the image within a limited range. Only part of the reference is used during correlation and the image pixels of that reference belong to the object. Parts that do not belong to the object are masked by

object windowing or object masking. The location of the correlation maximum supplies the current position of the object in the image, because the image pixels there agree with the object pixels.

[0005] This known process however is problematic in that the correlation no longer provides the correct position of the object when it happens to be partly covered up, because one correlates in the covered area with image pixels that do not belong to the object. Due to this coverup, only part of the object is compared to the reference, which leads to an inaccurate recognition of the object or of the position of the object. Imprecise recognition of the coverage area very quickly yields an erroneous object position in the image.

[0006] It is therefore a purpose of the present invention to provide a process for rediscovering objects in images, which will facilitate precise recognition and precise determination of the object position.

[0007] Another object of the invention is to provide a system for the rediscovery of objects in images, with which the object position can be determined precisely.

[0008] These and other objects and advantages are achieved by the method and apparatus for rediscovery of objects according to the invention, which includes a correlation of an object reference with image values. If an object is partially obscured (covered up), the image values that are within the coverage area in the image, are replaced by gray values of the object or of an object reference, before the correlation is performed. In that way, the errors connected with the rediscovery of the object are significantly reduced.

[0009] As part of this process, a reference image is preferably subjected to interference windowing in order to replace the image values within an interference mask by the gray values of the object. Advantageously, the reference image is subjected to object windowing in order to get the object reference.

[0010] In the present invention, especially prior to coverup, an image of the complete object is stored, and is used to determine the position of the object in case of a partial coverup. Advantageously, covered parts of the object in the image are replaced by parts of a stored reference.

[0011] The invention-based system for the rediscovery of objects in images includes a camera to take a picture, an image

data memory to store an object reference, an image data processor to replace gray values that lie in the image within a coverup area with gray values of the object reference, and a correlation unit that correlates the image - altered by the image data processor - with the object reference. The invention-based system is able precisely to recognize the coverup area and to determine a precise object position in the image. Errors are avoided or substantially reduced in that the already stored information on the appearance of the object is employed.

[0012] The invention is guided by a basic cybernetic idea: the system stores the image of the complete object and uses this information to determine what is behind the coverup. This technique is patterned after the human observer, who remembers the image of the complete object and who has an idea of what is behind the coverup. As a result, one can determine precisely the position of the object in case of partially covered objects.

[0013] Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Figure 1 graphically illustrates the individual steps of the invention-based process; and

[0015] Figure 2 is a flow chart of the invention-based process.

DETAILED DESCRIPTION OF THE DRAWINGS

[0016] Figure 1 shows the steps of the invention-based process by way of example, on the basis of target tracking. The target or object 1 is initially visible, but as time goes on, it disappears behind an obstruction 2, which covers it up. At a certain point in time, one or more parts 1a of object 1 can still be recognized, while the remaining parts of object 1 are behind the obstruction 2. If a picture is taken at that point in time, it contains object 1 which is partially covered by obstruction 2.

[0017] From a known reference image, which contains the target or object 1, an object mask 10 is produced. Object mask 10 is superimposed with the picture that was taken and that contains target 1 behind obstruction 2. This can be done so long as part 1a of object 1 can still be seen in the image. By

superpositioning object mask 10 with the partially obscured object and the obstruction, an interference mask 20 is created, which is superposed on obstruction 2. That is, interference mask 20 consists of those parts of the obstruction 2 that cover the remaining parts of the object 1 in the image.

[0018] By means of an image data processor, the image pixels inside interference mask 20 are replaced by the gray values of object 1 that are taken from the reference image. This results in a replacement 21 with image pixels that correspond to just the covered parts of object 1. Replacement 21 is then inserted in the picture that was taken in the area of interference mask 20 so that the image now generated contains the complete object 1, without any parts of object 1 missing. The image, thus generated with the help of the image data processor, forms a foundation for further procedural steps.

[0019] From the stored reference image (that, as described above, contains object 1), a reference or object reference 11 is created, with the help of object mask 10. Object reference 11 is now correlated with image 22 that contains replacement 21. The correlation maximum is determined by means of a peak detection. The location of the correlation maximum thus supplies the precise position of object 1 in the picture.

[0020] Figure 2 is a block diagram which shows the process for the automatic location or rediscovery of object 1 in the picture that was taken. The data of a reference image 201 are subjected to interference windowing 202, and those image parts 203 in which the object is behind the obstruction are replaced with the gray values of the object from the reference image in block 204. The reference image is also subjected to object windowing 205 that, as a result, supplies the object reference. In a correlation unit 206, the object reference is correlated with the image that contains the replacement from block 204. Finally, in order to determine the correlation maximum and the position of the object, a peak detection 207 is performed. (In the process, the reference image for example is a previously taken picture that contains object 1.)

[0021] In the method and apparatus according to the invention, in the search area of the image, the gray values of the obstruction are replaced by the gray values of the object; as a result, considerably increased precision of recognition and position determination of objects is achieved. Moreover, there is considerably less intervention in the signals that are subject to correlation than during the out-masking of entire image portions. Errors during position determination are reduced considerably by storing the previously obtained information on

the appearance of the object and by using this information to find the object behind an obstruction.

[0022] The foregoing disclosure has been set forth merely to illustrate the invention and is not intended to be limiting. Since modifications of the disclosed embodiments incorporating the spirit and substance of the invention may occur to persons skilled in the art, the invention should be construed to include everything within the scope of the appended claims and equivalents thereof.

METHOD AND APPARATUS FOR LOCATING OR REDISCOVERING PARTIALLY  
OBSCURED OBJECTS IN IMAGES

BACKGROUND AND SUMMARY OF THE INVENTION

This application claims the priority of German patent document 199 02 681.5, filed 23 January 1999 (23.01.99) and PCT International Application No. 99/DE99/04064, filed 22 December 1999, the disclosure of which is expressly incorporated by reference herein.

This invention relates to a [process for finding] method and apparatus for locating or rediscovering partially obscured objects in images. [again] by correlation of an object reference with image values. [, as well as a system for rediscovering objects in images.]

Numerous practical uses require objects to be automatically rediscovered in images or digital image sequences. But it can happen that parts of the object are covered up or obscured by obstructions in the field of view.

In a known process for [, that facilitates the] rediscovery of objects in images, the object image to be [searched for] located stores a reference and that reference is subsequently correlated with the image within a limited range. Only part of

the reference is used during correlation and the image [dots] pixels of that reference belong to the object. Parts that do not belong to the object are masked [up] by object windowing or object masking. The [place] location of the correlation maximum supplies the current position of the object in the image, because the image [dots] pixels there agree with the object pixels.

This known process however [entails the following problem:] is problematic in that the correlation no longer provides the correct position of the object when it [the object] happens to be partly covered up, because [. Here is why:] one correlates in the covered area with image [dots] pixels that do not belong to the object. Due to this coverup, only part of the object is compared to the reference, [something that] which leads to an inaccurate recognition of the object or of the position of the object. Imprecise recognition of the coverage area very quickly yields an erroneous object position in the image.

It is therefore [the] a purpose of [this] the present invention to provide a process for rediscovering objects in images, which will facilitate precise recognition and precise determination of the object position.

Another object of the invention is to provide [Furthermore,]  
a system [is to be provided] for the rediscovery of objects in

images, with which the object position can be determined precisely.

These and other objects and advantages are achieved by the method and apparatus [This problem is solved by the process] for [the] rediscovery of objects according to the invention, which includes [in images according to Claim 1 and the system for rediscovering objects in images according to Claim 6. Other advantageous features, aspects, and details of the invention will emerge from the subclaims, the specification, and the drawings.

The invention-based process for the rediscovery of objects in images comprises] a correlation of an object reference with image values. If [where - if] an object is partially obscured [covered up] [-] the image values[,] that are within the coverage area in the image, [will be] are replaced by gray values of the object or of [the] an object reference, before the correlation is performed. In that way, [one can considerably reduce] the errors connected with the rediscovery of the object are significantly reduced.

As part of this process, a reference image is preferably subjected to interference windowing in order to replace the image values within an interference mask by the gray values of the

object. Advantageously, the reference image is subjected to object windowing in order to get the object reference.

In the present invention, [at hand,] especially prior to coverup, [the] an image of the complete object is stored, [in order] and is used to determine the position of the object in case of a partial coverup. Advantageously, covered parts of the object in the image are replaced by parts of a stored reference.

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[The basic cybernetic idea] This technique is patterned after [guided by] the human observer, who remembers the image of the complete object and who has an idea of what is behind the coverup. [This basic cybernetic idea is used in this invention and is expressed in technical terms, as] As a result, [of which] one can [very precisely] determine precisely the position of the object in case of partially covered objects.

Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[The invention will be described below by way of example and with reference to the drawings.]

Figure 1 graphically illustrates the individual steps of the invention-based process; and

Figure 2 is a flow chart of the invention-based process.

DETAILED DESCRIPTION OF THE DRAWINGS

Figure 1 shows the steps of the invention-based process by way of example, on the basis of target tracking. [First of all, one can see a] The target or object 1 is initially visible, but [that,] as time goes on, it disappears behind an obstruction [a coverup] 2, which covers it up. At a certain point in time, one or [several] more parts 1a of object 1 can still be recognized, while the remaining parts of object 1 are behind [coverup] the obstruction 2. If a picture is taken at [At] that point in time, [a picture is taken and] it contains object 1 which is partially covered by [coverup] obstruction 2.

From a known reference image, [in] which [is contained] contains the target or object 1, [one now produces] an object mask 10 is produced. Object mask 10 is [supposed] superimposed with the picture that was taken and that contains target 1 behind [coverup] obstruction 2. [That] This can be done so long as part 1a of object 1 can still be seen in the image. By [superposition with] superpositioning object mask 10 with the partially obscured object and the obstruction, [one gets] an interference mask 20 is created, which is superposed on [coverup] obstruction 2. That is, interference [Interference] mask 20 consists of [contains]

those parts of [coverup] the obstruction 2 that cover the remaining parts of the object 1 in the image.

By means of an image data processor, the image [dots] pixels inside interference mask 20 are replaced by the gray values of [odds] object 1 that are taken from the reference image. This results in [One gets] a replacement 21 with image [dots] pixels that correspond to [the] just the covered parts of object 1. Replacement 21 is then inserted in the picture that was taken in the area of interference mask 20 so that the image now generated contains the complete object 1, without any parts of object 1 missing. The image, thus generated with the help of the image data processor, forms a foundation for further procedural steps.

From the stored reference image[,] that, as described above, contains object 1, [one gets] a reference or object reference 11 is created, with the help of object mask 10. Object reference 11 is now correlated with image 22 that contains replacement 21. The correlation maximum is determined by means of a peak detection. The location [place] of the correlation maximum thus supplies the precise position of object 1 in the picture.

Figure 2 is a [flow chart showing] block diagram which shows the process [steps] for the automatic [finding] location or

rediscovery of object 1 in the picture that was taken. The data of a reference image 201 are subjected to interference windowing 202, and [ ]. This is followed by the replacement of] those image parts 203 [-] in which the object is behind the [coverup -] obstruction are replaced with the gray [value] values of the [objects] object from the reference image in block 204. [Furthermore, the] The reference image is also subjected to object windowing 205 that, as a result, supplies the object reference. In a correlation [step,] unit 206, the object reference is correlated with the image that contains the replacement from block 204. [Last, one performs the peak detection] Finally, in order to determine the correlation maximum and the position of the object, a peak detection 207 is performed. (In the process, the reference image for example is a previously taken picture that contains object 1.)

In the method and apparatus according to the invention, [at hand,] in the search area of the image, the gray values of the [coverup] obstruction are replaced by the gray values of the object; as a result, [one gets] considerably increased precision of recognition and position determination of objects is achieved. Moreover, there [There] is considerably less intervention in the signals that are subject to correlation than during the outmasking of entire image portions. Errors during position determination are reduced considerably [reduced] by storing the

previously obtained information on the appearance of the object and by using this information to find the object behind [a coverup] an obstruction.

The foregoing disclosure has been set forth merely to illustrate the invention and is not intended to be limiting. Since modifications of the disclosed embodiments incorporating the spirit and substance of the invention may occur to persons skilled in the art, the invention should be construed to include everything within the scope of the appended claims and equivalents thereof.

## Process and System for Rediscovering Objects in Images Again

This invention relates to a process for finding objects in images again by correlation of an object reference with image values, as well as a system for rediscovering objects in images.

Numerous practical uses require objects to be automatically rediscovered in images or digital image sequences. But it can happen that parts of the object are covered up.

In a known process, that facilitates the rediscovery of objects in images, the object image to be searched for stores a reference and that reference is subsequently correlated with the image within a limited range. Only part of the reference is used during correlation and the image dots of that reference belong to the object. Parts that do not belong to the object are masked up by object windowing or object masking. The place of the correlation maximum supplies the current position of the object in the image because the image dots there agree with the object pixels.

This known process however entails the following problem: the correlation no longer provides the correct position of the

object when the object happens to be partly covered up. Here is why: one correlates in the covered area with image dots that do not belong to the object. Due to this coverup, only part of the object is compared to the reference, something that leads to an inaccurate recognition of the object or of the position of the object. Imprecise recognition of the coverage area very quickly yields an erroneous object position in the image.

It is therefore the purpose of this invention to provide a process for rediscovering objects in images, which will facilitate precise recognition and precise determination of the object position. Furthermore, a system is to be provided for the rediscovery of objects in images, with which the object position can be determined precisely.

This problem is solved by the process for the rediscovery of objects in images according to Claim 1 and the system for rediscovering objects in images according to Claim 6. Other advantageous features, aspects, and details of the invention will emerge from the subclaims, the specification, and the drawings.

The invention-based process for the rediscovery of objects in images comprises a correlation of an object

reference with image values where - if an object is partially covered up - the image values, that are within the coverage area in the image, will be replaced by gray values of the object or of the object reference, before the correlation is performed. In that way, one can considerably reduce the errors connected with the rediscovery of the object.

As part of this process, a reference image is preferably subjected to interference windowing in order to replace the image values within an interference mask by the gray values of the object.

Advantageously, the reference image is subjected to object windowing in order to get the object reference.

In the invention at hand, especially prior to coverup, the image of the complete object is stored in order to determine the position of the object in case of a partial coverup. Advantageously, covered parts of the object in the image are replaced by parts of a stored reference.

The invention-based system for the rediscovery of objects in images comprises a camera to take a picture, an image data memory to store an object reference, an image data processor to replace the gray values that lie in the image within a

coverup area, with gray values of the object reference, and a correlation unit that correlates the image - altered by the image data processor - with the object reference. The invention-based system is able precisely to recognize the coverup area and to determine a precise object position in the image. Errors are avoided or extensively reduced in that the already stored information on the appearance of the object is employed.

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Figure 1 shows the steps of the invention-based process by way of example, on the basis of target tracking. First of all, one can see a target or object 1 that, as time goes on, disappears behind a coverup 2. At a certain point in time, one or several parts 1a of object 1 can still be recognized, while the remaining parts of object 1 are behind coverup 2. At that point in time, a picture is taken and it contains object 1 which is partially covered by coverup 2.

From a known reference image, in which is contained the target or object 1, one now produces an object mask 10. Object mask 10 is supposed with the picture that was taken and that contains target 1 behind coverup 2. That can be done so long as part 1a of object 1 can still be seen in the image. By superposition with object mask 10, one gets an interference mask 20 which is superposed on coverup 2. Interference mask

20 contains those parts of coverup 2 that cover the remaining parts of the object 1 in the image.

By means of an image data processor, the image dots inside interference mask 20 are replaced by the gray values of odds 1 that are taken from the reference image. One gets a replacement 21 with image dots that correspond to the just covered parts of object 1. Replacement 21 is inserted in the picture that was taken in the area of interference mask 20 so that the image now generated contains the complete object 1, without any parts of object 1 missing. The image, thus generated with the help of the image data processor, forms a foundation for further procedural steps.

From the stored reference image, that, as described above, contains object 1, one gets a reference or object reference 11 with the help of object mask 10. Object reference 11 is now correlated with image 22 that contains replacement 21. The correlation maximum is determined by means of a peak detection. The place of the correlation maximum thus supplies the precise position of object 1 in the picture.

Figure 2 is a flow chart showing the process steps for the automatic finding or rediscovery of object 1 in the

picture that was taken. The data of a reference image are subjected to interference windowing. This is followed by the replacement of those image parts - in which the object is behind the coverup - with the gray value of the objects from the reference image. Furthermore, the reference image is subjected to object windowing that, as a result, supplies the object reference. In a correlation step, the object reference is correlated with the image that contains the replacement. Last, one performs the peak detection in order to determine the correlation maximum and the position of the object. In the process, the reference image for example is a previously taken picture that contains object 1.

In the invention at hand, in the search area of the image, the gray values of the coverup are replaced by the gray values of the object; as a result, one gets considerably increased precision of recognition and position determination of objects. There is considerably less intervention in the

signals that are subject to correlation than during the out-masking of entire image portions. Errors during position determination are considerably reduced by storing the previously obtained information on the appearance of the object and by using this information to find the object behind a coverup.

CLAIMS

1. Process for the relocation of objects and images by correlation of an object reference (11) with image values, characterized in

that, in case of a partial coverup (2) of an object (1), the image values, that lie in the image within the coverage area, are replaced by gray values of object (1), before correlation is performed.

2. Process according to Claim 1, characterized in that a reference image is subjected to interference windowing in order to replace the image values within an interference mask (20) with the gray values of object (1).

3. Process according to Claim 1 or Claim 2, characterized in that the reference image is subjected to object windowing in order to get the object reference (11).

4. Process according to one of the above Claims, characterized in that, prior to coverup, the image of the complete object (1) is stored in order to determine the position of object (1) in case of a partial coverup.

5. Process according to one of the above Claims,

characterized in that parts (1a) of object (1), that are covered up in the image, are replaced by parts of a stored reference.

6. System for relocating objects and images,

characterized by

a camera to take a picture,

an image data memory to store an object reference,

an image data processor to replace gray values that are within a coverage area in the image, with gray values of the object reference and

a correlation unit that correlates the image, altered by the image data processor, with the object reference.

Abstract

In a process for rediscovering objects in images, an object reference is correlated with image values. In case of a partial coverup of the object in the image, those image values, that lie inside the coverage area in the image, are replaced by gray values of the object, before the correlation is performed. A system for rediscovering objects in images has a camera to take a picture, an image data memory to store an object reference, an image data processor to replace gray values, that lie within a coverage area, with gray values of the object reference, and a correlation unit that correlates the image, altered by the image data processor, with the object reference.

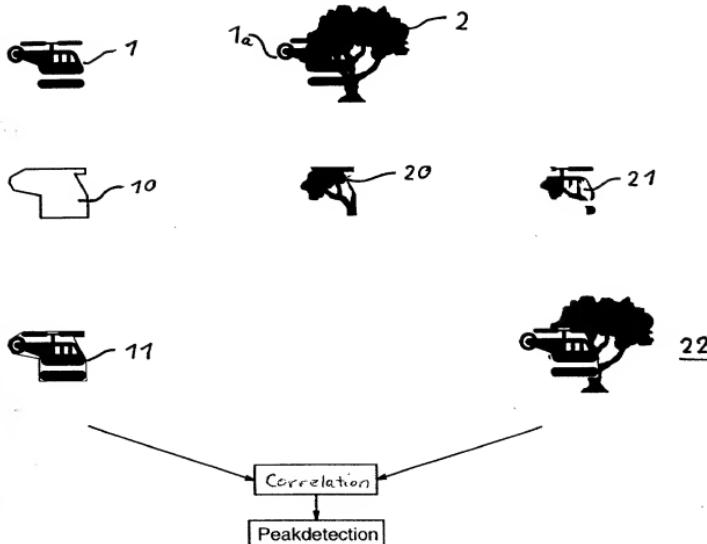


Fig. 1

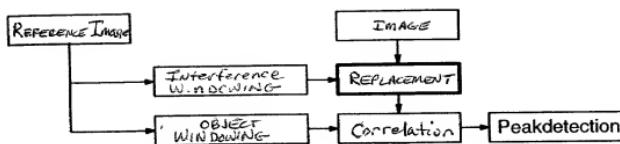


Fig. 2

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY  
(includes Reference to PCT International Applications)

ATTORNEY'S DOCKET NUMBER  
420LFK/50014  
41

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD AND SYSTEM FOR RELOCATING HIDDEN OBJECTS IN IMAGES

the specification of which (check only one item below):

is attached hereto.

was filed as United States application  
Serial No. \_\_\_\_\_  
on \_\_\_\_\_  
and was amended  
on \_\_\_\_\_ (if applicable).

was filed as PCT international application  
Number PCT/de99/04064  
on 22 December 1999  
and was amended under PCT Article 19  
on \_\_\_\_\_ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United State Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY (if PCT indicate PCT)	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119
Germany	199 02 681.5	23 January 1999 (23.01.99)	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> No



23911  
PATENT TRADEMARK OFFICE

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT  
UNDER 35 U.S.C. 120

U.S. APPLICATIONS

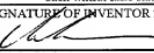
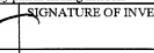
U.S. APPLICATION NUMBER	U.S. FILING DATE	PATENTED	PENDING	ABANDONED

PCT APPLICATIONS DESIGNATING THE U.S.

PCT APPLICATION NO	PCT FILING DATE	U.S. SERIAL NUMBERS ASSIGNED (IF ANY)		

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (List name and registration number)

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	RESIDENCE & CITIZENSHIP <b>CITY</b>	POST OFFICE ADDRESS	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
	POST OFFICE ADDRESS	POST OFFICE ADDRESS <b>CITY</b>	CITY	STATE & ZIP CODE/COUNTRY
<p>I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and that like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.</p>				
SIGNATURE OF INVENTOR 201 	SIGNATURE OF INVENTOR 202 	SIGNATURE OF INVENTOR 203 		
DATE <b>06.09.01</b>	Date <b>03.09.01</b>	DATE		